PATENT SPECIFICATION

811703

Date of filing Complete Specification: July 12, 1955.

Application Date: July 12, 1954. No. 20371/54.

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Index at acceptance:—Classes 36, A(3G: 5); and 87(2), A1G(1: 5E: 7C), A1R39H.

International Classification:—B29d. H01b.

COMPLETE SPECIFICATION

Electric Cables and method of and means for Manufacturing same

We. SHARPLOW [illegible]

CORRECTION OF CLERICAL ERROR/8

SPECIFICATION NO. 811,703

The following correction is in accordance with the Decision of the Superintending Examiner, acting for the Comptroller-General, dated the twentysixth day of April, 1962.

Page 4, line 11, *for* "Cable" *read* "cable"

Page 4, line 12, *for* "but" *read* "due"

Page 4, line 25, *for* "extricated" *read* "extruded"

Page 4, line 53, *for* "arrayed" *read* "arranged"

Attention is also directed to the following printer's errors:-

Page 1, line 1, *for* "ELECTRICAL" *read* "ELECTRIC"

Page 4, line 49, *for* "os" *read* "on"

THE PATENT OFFICE,
21st May, 1962

DS 64107/1(2)/R.109 200 5/62

unto the cable di-electric, because both the power factor and di-electric constant of dry air are considerably lower than any known solid material. At the lower radio frequencies the attenuation in feeder cables insulated with a solid material of good electrical characteristics is not excessive in lengths normally used, but as the frequency increases so does the loss and at high frequencies (50 Mcs/sec and higher for example) loss of signal may be serious especially if the signal strength is low and the run of cable is of normal length of fifty feet or so.

Co-axial cables have been made in the past with air spaces or cells formed in the di-electric. For example, polythene has been applied as a thread helically around the con- [illegible] and remain accurately maintained in position in relation to the conductor.

A further object is to produce a cable in a single extruding operation with a stationary die.

According to the invention there is provided a method of manufacturing insulated electric cables by an extrusion process from a non-rotating die having an outer annular gap of a size corresponding to an outer tubular envelope of the cable, such gap being connected by a plurality of radial gaps to a central cavity larger than and through which the conductor passes at a controlled speed and having between each radial gap orifices through which air can be forced under pressure, in which there is forced through the gaps and cavity a heated thermoplastic liquid insulant at such a

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COMPLETE SPECIFICATION

Electric Cables and method of and means for Manufacturing same

We, SHARDLOW ELECTRICAL WIRES LIMITED, a British Company, of 226/232 Corn Exchange Buildings, Manchester, Lancashire, and FRANCIS GEORGE HARGREAVES, a British Subject, of 60 Mossley Road, Ashton-under-Lyne, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to electric cables and methods of and means for manufacturing same, and it concerns in particular electric cables of the type having one or more conductors which are within a di-electric and which also have an outer metal conductor (usually woven wire or braiding), such cables having a characteristic surge impedance, the ohmic value of which is dependent mainly upon the conductor gauge and spacing used and the nature of the di-electric between the conductor or conductors and the outer conductor. The more usual form of such cable is one wherein a single conductor is provided on the axis of the cable, these cables being known as "co-axial cables."

It is well known that power loss in co-axial and similar cables used for the transference of high frequency radio and other signals can be reduced significantly by introducing air spaces into the cable di-electric, because both the power factor and di-electric constant of dry air are considerably lower than any known solid material. At the lower radio frequencies the attenuation in feeder cables insulated with a solid material of good electrical characteristics is not excessive in lengths normally used, but as the frequency increases so does the loss and at high frequencies (50 Mcs/sec and higher for example) loss of signal may be serious especially if the signal strength is low and the run of cable is of normal length of fifty feet or so.

Co-axial cables have been made in the past with air spaces or cells formed in the di-electric. For example, polythene has been applied as a thread helically around the conductor of a co-axial cable, this thread being maintained in a tube of polythene, and also a deep ribbed core of polythene has been applied to the conductor producing a star-section arrangement, this also being maintained within a polythene tube.

It has been proposed to manufacture coaxial cables by extruding an insulant through a stationary die to form a cable with a conductor having spaced from it by a rib or ribs of an insulant an outer envelope of insulant, but in such proposal the conductor was not embedded in a sheath of the insulant.

It has also been proposed to manufacture coaxial cables by extruding an insulant through a rotary die so as to produce a cable with its conductor embedded in a sheath of the insulant which is spaced by a helical rib or ribs of the insulant from an outer envelope of insulant.

An object of the present invention is to provide an improved method of and apparatus for manufacturing insulated electric cables having cavities or cells extending uniformly and continuously through the di-electric in which the conductor is embedded in a sheath of insulant and in which the di-electric has sufficient strength for the cable to stand up to normal handling and use so that the di-electric will be and remain accurately maintained in position in relation to the conductor.

A further object is to produce a cable in a single extruding operation with a stationary die.

According to the invention there is provided a method of manufacturing insulated electric cables by an extrusion process from a non-rotating die having an outer annular gap of a size corresponding to an outer tubular envelope of the cable, such gap being connected by a plurality of radial gaps to a central cavity larger than and through which the conductor passes at a controlled speed and having between each radial gap orifices through which air can be forced under pressure, in which there is forced through the gaps and cavity a heated thermoplastic liquid insulant at such a

temperature and rate that the same will set soon after emerging from the die and in which at the same time air is forced under a controlled pressure through each of the plurality of orifices, the air pressure being controlled at such a pressure as to maintain such air spaces between each of the radial ribs that the insulated cable sets with the conductor embedded in an annular sheath of the insulant connected by radial ribs of insulant to the outer tubular envelope of insulant of a size corresponding to the outer annular gap.

The invention also consists of an apparatus for manufacturing insulated electric cables by an extrusion process through a die comprising a non-rotating die having an outer annular gap connected by a plurality of radial gaps to an inner central cavity larger than the conductor and so disposed that the conductor will pass through the same and having between each radial gap orifices, there being provided means for forcing through the gaps and cavity a heated thermoplastic insulant and means for forcing through each of the orifices air at a controlled pressure.

The embedding of the conductor in this inner covering results in a construction which is strong and will not twist or distort in normal use. The whole di-electric is formed in one piece as a unitary structure and can easily be covered with the usual braided or other metal outer and protective cover.

Preferably the insulant is polythene or other synthetic plastic material having the desired physical and electrical characteristics.

In accordance with the invention, there is produced a cable in which the di-electric consists of a proportion of insulant and a proportion of air by virtue of the cells which run through the di-electric. The conductor is held embedded within a covering of the solid insulant from which ribs extend to an outer envelope, and as a result, there is resistance to deformation or twisting or serious eccentricity of the conductor such as might occur by careless laying or damage. The power-loss decreases as the proportion of air to solid di-electric increases, and the proportional limits are determined mainly by the physical considerations involved. By correct adjustment of the air pressure in relation to the extrusion pressure, it is possible to compensate for any physical variations which might occur in the extruded insulant.

In order that a clear understanding of the invention may be obtained reference will now be made to the accompanying drawings, which show diagrammatically a preferred form of extrusion head and die in accordance with the invention. In the drawings, Fig. 1 is a longitudinal sectional view through the head and Fig. 2 is a front perspective view to an enlarged scale of the die, with part broken away.

Referring to Fig. 1, the head generally is of conventional form, including a hollow body 10 into which heated polythene in a liquid form is force fed through an inlet 11 by means of a scroll and feed mechanism 12. The die case 13 is located on the front of the body, and has passages 14 to allow for the extrusion of the polythene.

The die includes inner part or point I, coaxial with an inner space or chamber 16. The inner part I has a central orifice 19, feeding into a cavity 20, and the conductor C which may be single or multi-strand is fed in from the rear end of the chamber 16 and passes through said chamber, through the orifice 19 and cavity 20 and out through the die point, the plastic insulant D coating same during the extrusion operation. The point has a number of radial gaps or slots 15 from its outer surface to the cavity 20 (Fig. 2).

The point end is built up so that a number of air outlet orifices 17 are provided located concentrically around the conductor outlet orifice, one in each part of the point between adjacent gaps 15. Preferably five such gaps and air outlet orifices are provided equispaced around a circle, one gap being shown in Figure 1.

It will be seen from Fig. 2, that the insulant D is forced down the slots 15 into the cavity 20 and also passes along the outer surface of the point I so that the conductor C is embedded in a coating or inner sheath from which ribs radiate to an outer tubular envelope.

An air inlet 18 is provided into the chamber 16, this being supplied from a suitable compressor through reducing valve and control, so that air under pressure is fed into the chamber and is forced from the air jet orifices 17 into the cells formed between the gaps 15. In figure 2, the full line arrows indicate the path of the liquid insulant, and the broken line arrows the path of the air. By suitably controlling the air pressure, and rate of feed of the insulant and conductor, the formed cable can be produced with a number of cells or cavities through the di-electric along and around the conductor.

An outer conductor, such as braided metal, may be provided over the di-electric, this outer conductor being sheathed in an outer protective cover in the usual way. The outer conductors are not shown being no part of the invention.

It is to be noted that by alteration in the air pressure it is possible to compensate for changes in viscosity or resilience which may occur in the hot extruded insulant which is of a liquid nature.

Further, the present invention ensures that a coating of insulant is applied to the conductor. In order to maintain the desired electrical characteristics of the cable, it is necessary to ensure that there is no undue displacement of the core in relation to the outer conductor which is likely to occur if the cable is

bent or twisted in use. The invention herein ensures sufficient rigidity to prevent undue displacement in use, whilst providing a di-electric ensuring low power loss.

WHAT WE CLAIM IS:—

1. Method of manufacturing insulated electric cables by an extrusion process from a non-rotating die having an outer annular gap of a size corresponding to an outer tubular envelope of the cable, such gap being connected by a plurality of radial gaps to a central cavity larger than and through which the conductor passes at a controlled speed and having between each radial gap orifices through which air can be forced under pressure in which there is forced through the gaps and cavity heated thermoplastic liquid insulant at such a temperature and rate that the same will set soon after emerging from the die and in which at the same time air is forced under a controlled pressure through each of the plurality of orifices, the air pressure being controlled at such a pressure as to maintain such air spaces between each of the radial ribs that the insulated cable sets with the conductor embedded in an annular sheath of the insulant connected by radial ribs of insulant to the outer tubular envelope of insulant of a size corresponding to the outer annular gap.

2. Apparatus for manufacturing insulated electric cables by an extrusion process through a die comprising a non-rotating die having an outer annular gap connected by a plurality of radial gaps to an inner central cavity larger than the conductor and so disposed that the conductor will pass through the same and having between each radial gap orifices, there being provided means for forcing through the gaps and cavity a heated thermoplastic insulant and means for forcing through each of the orifices air at a controlled pressure.

3. An insulated electric cable, having an envelope of insulant connected by radial ribs of insulant to a sheath of insulant in which the conductor is embedded, when manufactured in accordance with the method claimed in Claim 1 or by the apparatus claimed in Claim 2.

4. A method according to Claim 1 or a cable according to Claim 3 in which the insulant is polythene or other synthetic plastic material having the desired physical and electrical characteristics.

5. Apparatus as claimed in Claim 2, wherein the die comprises an inner part or point having a centrally located orifice at its rear end leading into a co-axial cavity, and a plurality of equally spaced radial gaps in the form of slots extending from said cavity to the outer surface of said inner part, and an outer part disposed concentrically around the inner part and having its inner surface spaced from the outer surface of the inner part, and means are provided for feeding the di-electric into the space between said surfaces.

6. Apparatus as claimed in any of the preceding claims wherein means are provided for controlling the rate of feed of the conductor.

7. The method of manufacturing co-axial or like cables, substantially as herein described.

8. Apparatus for making co-axial or like feeder cables, substantially as herein described with reference to the accompanying drawings.

9. Co-axial cables when produced by the method or apparatus of any of the claims 1, 2, 4, 5, 6, 7 and 8.

T. B. BROWNE.

PROVISIONAL SPECIFICATION

Electric Cables and method of and means for Manufacturing same

We, SHARDLOW ELECTRIC WIRES LIMITED, a British Company of 226/232 Corn Exchange Buildings, Manchester, Lancashire, and FRANCIS GEORGE HARGREAVES, 60 Mossley Road, Ashton-under-Lyne, a British Subject, do hereby declare this invention to be described in the following statement:—

The present invention relates to electric cables and methods of and means for manufacturing same, and it concerns in particular electric cables of the type having one or more cores which are accurately spaced within an outer metal conductor (usually woven wire or braiding), such cables having a characteristic surge impedance the ohmic value of which mainly is dependent upon the core gauge and spacing used and the nature of the di-electric between the core or cores and outer conductor. Such cables generally being referred to as co-axial cables.

The primary object of the present invention is to provide a method of manufacturing co-axial cables, wherein a solid di-electric is provided having air cavities therethrough, which method is such that the moulding of the di-electric and formation of the cavities are carried out in one operation. A further object is to provide a method of manufacturing cables wherein the size of the cavities can be controlled or varied easily.

In accordance with the present invention the method broadly consists in covering the conductor or conductors with the solid insulating material such as polythene or like synthetic plastic material by an extrusion process as is usual, by feeding the material and conductor or conductors through a die-head, and in feeding to the die-head fluid under controlled pressure, said head being formed with outlet orifices whereby the pressure as the extrusion process proceeds, results in the production of a di-electric covering consisting of the material with passages or spaces therealong. Conveniently, the die head is formed so that the

spaces are symmetrically spaced around a centre conductor or core. The cable is encased in the outer conductor and protective outer cover in the usual way.

Cables manufactured in accordance with the present invention have a lower electrical loss at high frequencies compared with cables having a solid dielectric core. The number of cavities can be varied but for standard coaxial cables five is a convenient number. The cost of production of the Cable is cheaper than that with solid core, but to the substitution of air for dielectric material.

The invention also consists of an apparatus for producing cables as set forth, which apparatus includes an extrusion moulding head having a die formed with an aperture or apertures for the passage of the core or cores and arranged so that a plastic di-electric can be forced to sheath the said core or cores, and apertures providing jets for the passage of fluid e.g. air, under controlled compression, to the sheath of di-electric whereby cavities are blown in the di-electric as the cable with its di-electric sheath or insulant is extricated.

In one form, the extrusion head has an inner chamber through which a copper wire or core is fed. Air under pressure also is fed into this chamber. The die-head comprises an inner part with a part conical outer surface, and an outer part with a similar inner surface. The polythene or like plastic is forced under pressure from a compartment around the chamber, through a passage or passages into the space between the die-head parts, where it surrounds the core as same issues from the head. The inner part is provided with a part-conical co-axial cavity in communication with the chamber and this cavity feeds through a number of narrow passageways, out from the front or nose of the inner part. It will be understood that the outer part has a co-axial outlet aperture, so that as the process proceeds, the core is extruded from this aperture, within its di-electric. The passageways however, are such that the air pressure results in the formation of cavities through the extruded di-electric around the core. The size of the cavities will depend mainly os the pressure used, and speed of extrusion and their number and shape depends on the design of the die. Conveniently five cavities of equal cross-section are formed, symmetrically arrayed around the core, these being of a shape in cross-section tapering from their outer ends towards the inner ends i.e. towards the core. Thus the di-electric virtually consists of a centre "boss" around the core from which five ribs or spokes radiate all being united in an outer ring or rim part.

The air is conveniently fed from an air pump through a reducing valve into the head chamber.

F. G. HARGREAVES.

The common seal of SHARDLOW ELECTRIC WIRES LIMITED, was hereunto affixed in the presence of:—

A. S. HARGREAVES, Director,
R. MALLEY, Secretary.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1959.
Published by The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

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1962:—

811,703 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

Fig.1.

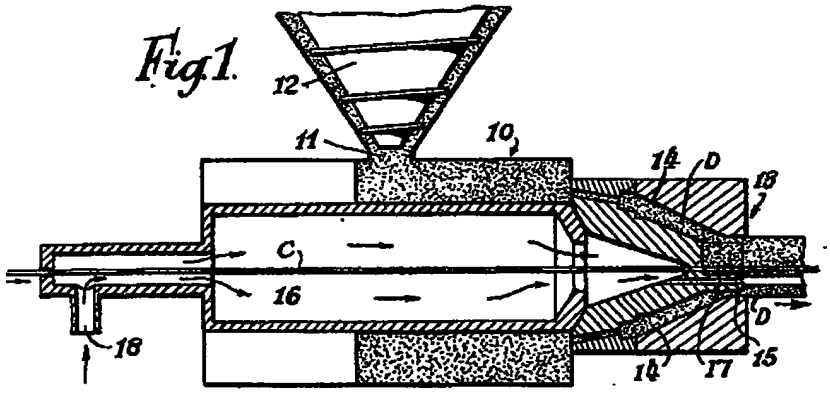

Fig.2.